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I, LEANNE MYNOTT, TEAM LEADER EXAMINATION SUPPORT AND SALES hereby certify that annexed is a true copy of the Provisional specification in connection with Application No. PP9998 for a patent by MITSUBISHI AUSTRALIA LIMITED filed on 28 April 1999.

WITNESS my hand this
First day of December 1999

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ORIGINAL

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PROVISIONAL SPECIFICATION FOR THE INVENTION ENTITLED:

IMPROVEMENTS IN OR RELATING TO CONTAINERS

~~The invention is described in the following statement:~~

agbm M10206855

IMPROVEMENTS IN OR RELATING TO CONTAINERS

The present invention is directed to improvements in or relating to containers, and more particularly to the delay of deterioration of perishable products by management of the composition of the atmosphere in contact with the product.

BACKGROUND OF THE INVENTION

In our co-pending Australian Provisional Patent Application No PP6588 filed 19 October 1998 we describe atmosphere adjustment apparatus for adjusting the atmosphere within a chamber, the apparatus including sealing means, inlet and outlet means, a controller, and optionally modification means for modifying the atmosphere within the chamber. The specification of that application is attached hereto and all disclosures in that specification are by this cross-reference incorporated herein.

In our co-pending Australian Provisional Patent Application No PP8642 filed 11 February 1999 we also describe atmosphere adjustment apparatus for adjusting the atmosphere within a chamber, the apparatus including sealing means, inlet and outlet means having a plurality of magnetically actuated valves, a controller, and optionally modification means for modifying the atmosphere within the chamber. The specification of that application is attached hereto and all disclosures in that specification are by this cross-reference incorporated herein.

Many items of perishable produce respire after harvest, that is, they consume oxygen and produce carbon dioxide. It is known that if the rate of respiration can be slowed during transportation, the produce will degrade less. The rate of respiration can be controlled by controlling the amount of oxygen and/or carbon dioxide available to the produce.

Many items of produce deteriorate after removal from the plant. This deterioration, which is usually given the term senescence, can be delayed by enclosing the perishable product in a chamber to which is applied well recognised methods, such as reduction of temperature below ambient room temperature, and/or the reduction of the concentration of oxygen below that occurring in air, and/or the elevation of the concentration of carbon dioxide above the concentration occurring naturally in air. Each of these conditions may be applied alone or in combination with any or all of the others.

However if the oxygen concentration is reduced too much or the carbon dioxide concentration rises too high, then the perishable product may be injured, resulting in even more rapid deterioration than might occur if no treatment was applied. Consequently it is desirable to

be able to adjust the composition of the atmosphere within the chamber and apparatus for adjusting the atmosphere in the chamber has accordingly been developed.

For transportation of perishable produce, the chamber referred to may be a shipping container, which in a common form may be fitted with a refrigeration system to adjust the temperature.

Controlled atmosphere containers are usually purpose built. However, controlled atmosphere apparatus may also be installed in a refrigerated container following a time-consuming and expensive operation.

Controlled atmosphere containers must be substantially sealed in order to separate the controlled atmosphere from the ambient atmosphere. It has been found that the door seals in controlled atmosphere containers are generally the source of most leakage of air. Every time the door is opened the seal is broken.

In one existing apparatus for controlling the atmosphere in a container, the atmosphere is taken from the container and passed through a device for actively modifying the atmosphere such as a carbon dioxide absorption tower and the modified atmosphere reintroduced into the container. The various devices for actively modifying the container atmosphere are expensive and generally difficult to service during transportation.

Where such apparatus is to be used to convert a refrigerated container to a controlled atmosphere container, holes may need to be made in the container walls to allow the container atmosphere to be drawn from the container to be modified and returned to the container. Such a process may need a permanent modification to be made to a refrigerated container and would be time consuming and expensive.

SUMMARY OF INVENTION

The present invention accordingly provides in one embodiment a method for adjusting the atmosphere within a chamber. In this embodiment the method includes the step of predicting the carbon dioxide level in the chamber once the oxygen setpoint in the chamber has been determined. In this way the carbon dioxide level in the chamber may be adjusted.

It has surprisingly been found that the carbon dioxide level in the chamber can be adjusted by altering the setpoint of oxygen in the chamber. In one preferred embodiment, the oxygen level in the chamber can be set above the oxygen setpoint after flushing the chamber with

a purging gas, following which the oxygen level degrades to the setpoint as a consequence of the respiring produce, resulting in a proportional increase in the carbon dioxide level in the chamber.

A significant advantage of the invention is that the carbon dioxide levels in the chamber can be accurately predicted remotely and before transport of the produce, ie the invention does not require active monitoring and control of the carbon dioxide levels while the produce is being transported. This obviates the need for complex carbon dioxide monitoring and control apparatus, as prediction of the carbon dioxide level can be made before the produce is placed in the chamber.

The present invention provides in another embodiment a method for independently adjusting carbon dioxide levels in a chamber, the method including the step of placing a carbon dioxide absorbing material in the chamber whereby carbon dioxide is absorbed into the material so that the level of carbon dioxide in the chamber reaches a desired equilibrium point. This aspect of the invention is predicated on the basis that if the rate of production of carbon dioxide in the chamber by the produce is known, a predetermined equilibrium can be achieved by adding the required amount of carbon dioxide absorbing material to the chamber. Hence independent adjustment of the carbon dioxide level in the chamber can be achieved.

A carbon dioxide absorbing material according to the invention may take any suitable form. In one embodiment, the carbon dioxide absorbing material comprises hydrated lime. The hydrated lime may be provided in the chamber in a container, cover or other carrier having predetermined permissivity to carbon dioxide. Other carbon dioxide absorbing materials are envisaged within the scope of the present invention.

If required, an initial carbon dioxide level inside the chamber can be set by including a portion of carbon dioxide in gaseous or solid form either during or after gas flushing.

Methods according to the invention may be used with atmosphere adjustment apparatus, adjusted atmosphere chambers, methods for converting a refrigerated shipping container to an adjusted atmosphere refrigerated shipping container, or methods for transporting perishable produce, as described in Australian Provisional Patent Application Nos PP6588 and PP8642.

The present invention provides in another embodiment atmosphere adjustment apparatus for adjusting the atmosphere within a chamber, the apparatus including modification means for modifying the atmosphere within the chamber.

A chamber according to the present invention may be provided within any form of receptacle.

The invention is particularly applicable to chambers provided within a receptacle in the form of a shipping container. While it is convenient to hereinafter describe the invention in relation to that example application it is to be appreciated that the present invention is equally applicable to chambers provided by or within other forms of receptacle including cool stores, refrigerated vans, rail cars and other storage facilities.

A chamber according to the present invention is generally a volume available within the receptacle for storing produce in an adjusted atmosphere. The chamber may comprise substantially the entire internal volume of the receptacle or a reduced volume within the chamber.

Where a chamber according to the present invention contains respiring produce, preferably the chamber is sealed to a sufficient extent that the rate of consumption of oxygen within the chamber exceeds the rate of leakage of oxygen into the chamber.

Inlet and outlet means may be provided in accordance with the present invention so as to facilitate respectively the inflow of ambient atmosphere into the chamber and the outflow of adjusted atmosphere from the chamber. Typical inlet and outlet means suitable for use in the practice of the present invention are described in Australian Provisional Patent Application Nos PP6588 and PP8642.

Modification means according to the invention includes means for adjusting the oxygen setpoint, and optionally passive means for increasing or decreasing the concentration of a component of the atmosphere in the chamber. Components which may be controlled using modification means include carbon dioxide, ethylene and humidity among others.

Modification means according to the present invention preferably includes a passive carbon dioxide concentration reduction means. The reduction means may in one embodiment comprise a carbon dioxide absorbing material. In one presently preferred embodiment the reduction means comprises a predetermined quantity of a suitable substance for extracting carbon dioxide from the atmosphere, such as hydrated lime, held in a carbon dioxide transmissible container or cover. The quantity of suitable substance to be placed within the chamber may be calculated from a knowledge of the total amount of carbon dioxide above the maximum tolerable amount of carbon dioxide within the chamber that is likely to enter the chamber and/or be produced through respiration of produce. This maximum amount may be estimated from a knowledge of the temperature at which the chamber is to be held, the time throughout which the atmosphere is to be adjusted and the respiration rate of the produce to be stored within the chamber.

After produce has been loaded into a chamber according to the present invention the chamber may be flushed with a gas having a low oxygen concentration or containing no oxygen. Nitrogen may be used as the gas. Such a gas flushing step may be effected to lower the initial oxygen concentration within the chamber to within a few percent of a predetermined maximum oxygen concentration, ie the oxygen setpoint. If the oxygen content is lowered to the oxygen setpoint, it has been observed that there is a corresponding proportional increase in the carbon dioxide level in the chamber.

Control of the oxygen setpoint and oxygen levels in the chamber can be achieved by the use of inlet and outlet means as described in Australian Provisional Patent Application Nos PP6588 and PP8642.

Prediction of the desired characteristics of the absorbing unit to achieve the desired concentration of carbon dioxide corresponding to a particular oxygen pre-set level in the chamber is also based on, amongst other things, the weight of the cargo, the temperature in the chamber, the time during which the cargo will be in transit, and the respiration quotient of the produce.

In one preferred embodiment of the present invention methods according to the invention include the determination of a respiration quotient of a particular produce to be placed in the chamber, that is the amount of oxygen which converts to carbon dioxide by respiration of that produce. The respiration quotient is produce dependent, although in general terms it has been observed there is a directly proportional relationship between the amount of oxygen consumed by the produce which converts to carbon dioxide. Hence, generation of carbon dioxide within the chamber has been found to be dependent on the oxygen level within the chamber. In a sealed chamber whose volume has produce and air, it has been observed that the produce consumes oxygen thereby reducing the oxygen level in the chamber. As a consequence of consumption of the available oxygen, the produce gives off a proportional amount of carbon dioxide to the oxygen consumed.

By way of example, it is well known that ambient air contains 21% oxygen by volume. If an oxygen level of 6% in a chamber containing produce and ambient air is required, it can be predicted in accordance with the present invention that the composition of the atmosphere in the chamber will over time contain 15% carbon dioxide (from a zero base) as a consequence of the consumption of oxygen by the produce. Similarly, if a level of 3% oxygen in the chamber is required, it can be predicted that the composition of the atmosphere in the chamber will over time contain 18% carbon dioxide (from a zero base) as a consequence of the consumption of oxygen by the produce.

In accordance with the method for independent adjustment of the carbon dioxide level, the carbon dioxide absorbing material may be provided so as to absorb the difference between the predicted level of carbon dioxide to be generated and a desired equilibrium point, say 10%. A calculation may hence in one embodiment be performed based on the known absorption characteristics of the carbon dioxide absorbing material and the desired degree of absorption of carbon dioxide, to arrive at an estimate of the amount of material required to absorb the difference in the predicted level of carbon dioxide and the desired carbon dioxide equilibrium point.

In general, a carbon dioxide level in the chamber in the range of about 0 to 15% by volume of the chamber is desired. The advantage of having at least a proportion of carbon dioxide in the composition of the chamber atmosphere is that it assists in the produce retaining its colour, inhibits the growth of mould and rots, and assists in retardation of produce ripening. Too much carbon dioxide could however cause deterioration in produce quality.

In accordance with one preferred embodiment of the present invention, if for example an oxygen setpoint of 5% by volume in the chamber is required, the oxygen level is initially reduced to within about 3% above the setpoint, following which the oxygen level degrades to 5% and the carbon dioxide level increases to 3% (from a zero base). The oxygen level can be held at the oxygen setpoint such as by allowing air into the chamber if the level falls below the setpoint.

Naturally however, the produce will continue to consume oxygen and hence carbon dioxide will continue to be produced. Independent adjustment of the carbon dioxide level can be achieved by placing a carbon dioxide absorbing material, such as one or more containers of hydrated lime of predetermined permissivity to carbon dioxide in the chamber, so as to absorb the difference between the predicted carbon dioxide level (based on the predicted rate of consumption of oxygen by the produce) and the desired level.

The present invention provides in one particularly preferred embodiment a method for adjusting the atmosphere within a chamber for containing respiring produce, the method including the steps of predicting the carbon dioxide level in the chamber once the oxygen setpoint in the chamber has been determined, and independently adjusting the carbon dioxide level in the chamber by determining the difference between the predicted level of carbon dioxide in the chamber and the desired carbon dioxide equilibrium point and adding one or more of containers of hydrated lime of predetermined permissivity to carbon dioxide to the chamber whereby carbon

dioxide is absorbed into the bags so that it reaches the desired equilibrium point, whereby to adjust the level of carbon dioxide in the chamber.

BRIEF DESCRIPTION OF PREFERRED EMBODIMENT

The present invention will now be described with reference to particularly preferred embodiments.

In the drawings, in which like integers are indicated by common reference numerals,

Figure 1 is a schematic side view of a standard refrigerated container fitted with atmosphere adjustment apparatus according to a preferred embodiment of the present invention; and

Figure 2 is an example of calculation of carbon dioxide levels in accordance with one embodiment of the present invention.

Turning to the drawings, Figure 1 shows generally a receptacle in the form of refrigerated container 10 which includes refrigeration unit 12 and doors 14, sealing means and inlet and outlet means. These integers are more fully described in Australian Provisional Patent Application Nos PP6588 and PP8642.

In the embodiment illustrated in Figure 1 the sealing means includes a curtain 16. The curtain preferably comprises an impervious sheet and is attached to the external walls of container 10 with tape (not shown) to form chamber 11. Modification means 9 comprising a quantity of hydrated lime held in carbon dioxide transmissible bags is located within chamber 11.

Sealing means (not shown) in the form of a cover for ventilation port 18 is located at the machinery end of the container 10. The cover comprises an impervious plastic sheet adhered with tape to the wall of the container 10. The cover is adapted to cover, and hence seal, ventilation port 18. The cover is fitted with outlet means in the form of a valve 20.

Valve 20 is located on the high pressure side of the fan so that when valve 20 is open, the adjusted atmosphere is forced out of the chamber.

Inlet means in the form of valves 70 are located in the curtain 16. Ambient atmosphere may enter chamber 11 when valves 70 are open.

Controller 8 includes sensor means (not shown) in the form of an oxygen concentration measurement device. The sensor means preferably takes measurements at equally spaced intervals which may be adjusted depending upon the rate of respiration (if any) of produce in chamber 11. If the oxygen concentration falls below a predetermined value (which can be adjusted depending

upon the rate of respiration (if any) of produce in the container), controller 8 sends a signal via wires 17 or other communication means to open valves 70 and 20. This allows the influx of ambient atmosphere into chamber 11 through valves 70 and the discharge of adjusted atmosphere from chamber 11 through valve 20.

Figure 2 shows a typical calculation sheet having a number of parameters which are required to enable the prediction in carbon dioxide levels to be made. In this example the produce to be transported is cauliflower, and it will be seen that the respiration quotient, that is the amount of oxygen which converts to carbon dioxide, is "1". Whilst the respiration quotient is produce dependent, in this example there is a directly proportional relationship between the amount of oxygen which converts to carbon dioxide.

In use, a prediction of the carbon dioxide level in the chamber based on the desired oxygen setpoint is made. The prediction is based on, amongst other things, the weight of the cargo, the temperature in the chamber, the time during which the cargo will be in transit, and the respiration quotient of the produce.

As the produce will continue to consume oxygen and hence carbon dioxide will continue to be produced, a prediction is also made based on the desired carbon dioxide setpoint, that is, the difference between the predicted carbon dioxide level (based on the predicted rate of consumption of oxygen by the produce) and the desired level. Independent control of the carbon dioxide level can be achieved by placing bags of hydrated lime of predetermined permissivity to carbon dioxide in the chamber so as to absorb the difference between the predicted and desired levels.

After produce has been loaded into container 10 curtain 16 is installed thereby forming substantially sealed chamber 11. Chamber 11 is flushed with nitrogen to lower the initial oxygen concentration within the controlled space to within a few percent by volume of a predetermined maximum oxygen concentration.

If controller 8 senses that the oxygen concentration within the chamber has fallen below a first predetermined minimum value, controller 8 sends a signal via wires 17 which causes both the inlet means and the outlet means in the form of valves 70 and 20 respectively to open for a ~~first predetermined length of time so as to allow air surrounding the chamber to enter chamber 11~~ and adjusted atmosphere within the chamber to leave chamber 11 under the influence of the fan.

The influx of air into chamber 11 thereby increases the oxygen concentration within chamber 11.

If, after valves 70 and 20 are closed, the oxygen concentration as measured by the sensor means has not increased to at least a second predetermined minimum value, controller 8 causes both valves 70 and 20 to switch to an open state for a second predetermined length of time so as to allow further air surrounding the chamber to enter chamber 11 and adjusted atmosphere from within chamber 11 to exit chamber 11 under the influence of the fan.

This process is repeated until the oxygen concentration has increased to an acceptable level.

In the embodiment illustrated ambient air is initially drawn into chamber 11 from space 15 between doors 14 and curtain 16. As adjusted atmosphere is driven from chamber 11 under the influence of the fan the pressure within chamber 11 drops.

The drop in pressure within chamber 11 causes curtain 16 to bow inwardly as shown in Figure 1. This action initially reduces the ambient pressure within space 15. However, as there is no need to have airtight door seals on container 10 for the application of the present invention, ambient air from outside container 10 is drawn through or around doors 14 into space 15 and subsequently into chamber 11.

Thus curtain 16 may act as a form of diaphragm moving with changes in respective pressure between chamber 11 and space 15 and acting to equalise the pressure therebetween when valves 70 are open.

Whilst it has been convenient to describe the present invention in relation to particularly preferred embodiments, it is to be appreciated that other constructions and arrangements are considered as falling within the scope of the invention. Various modifications, alterations, variations and/or additions to the constructions and arrangements described herein are also considered as falling within the scope of the present invention.

DATED THIS 27th day of April 1999

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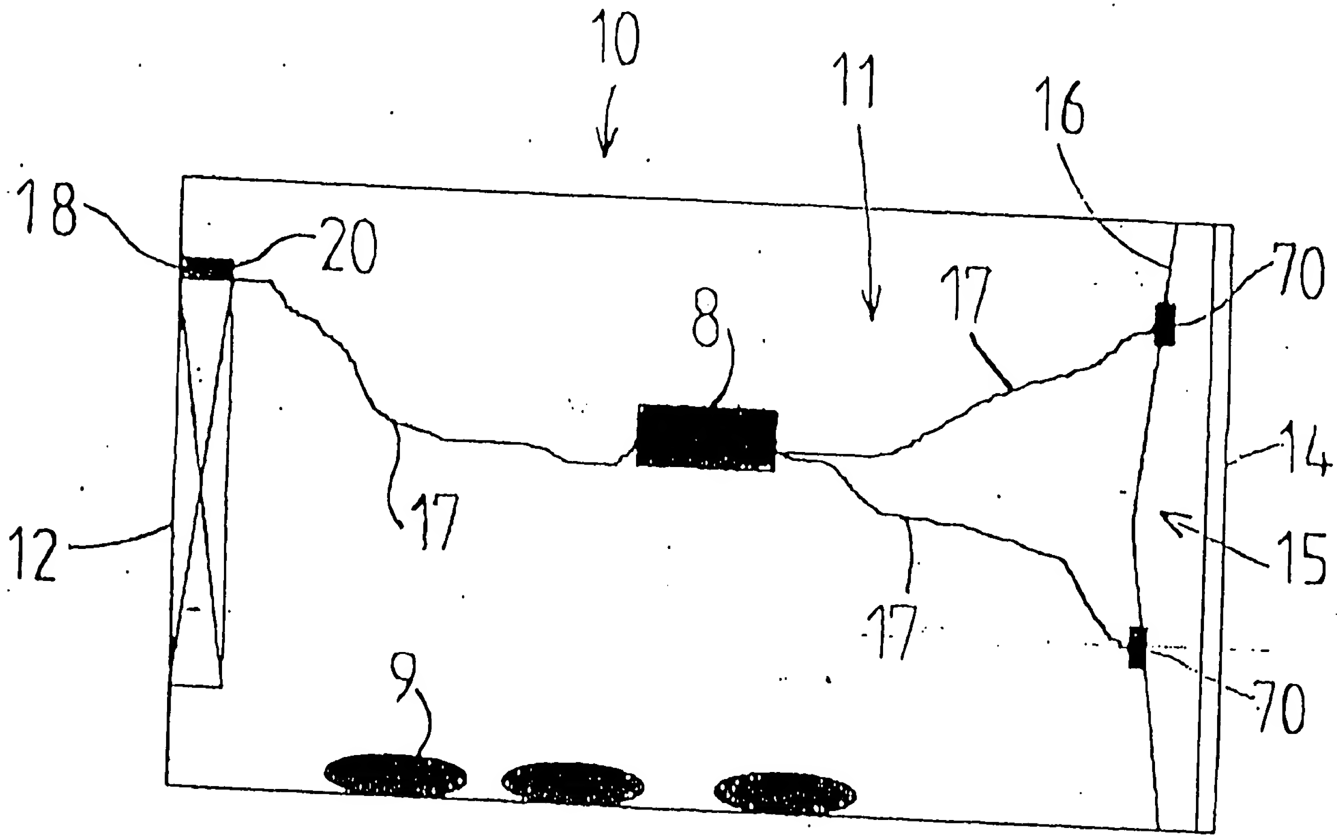

FIG 1

PASSIVE Carbon Dioxide CONTROL Calculations

Enter thes parameters : Time, Load, Bag dimensions, RQ, Respiration rate, Bag Rf, % oxygen, % carbon dioxide

Time	6 *weeks*			
Load	7000 *kg*			
Bag l x w	550	350 *mm*		
Rf	0.0017	Film		
RQ	1			
RespRate	15 *mg/kg.hr*	Product	Cauliflower	
% O2	2	Temp		0 °C
% CO2	5			

Bag area	0.39	m^2
kg lime	138.7	
Area m^2	82	
kg/m^2	2	
No bags	212	
kg/bag	0.653	Minimum
max/bag	4.6	

FIGURE 2